Optimized Combination of Reburning and SNCR

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Summary

As an alternative to SCR, GE-EER is developing a family of Advanced Reburning (AR) technologies, an integration of basic reburning and SNCR. These technologies provide NO_x control levels similar to that of SCR at much lower cost. In AR-Lean, N-agent (ammonia or urea) is injected along with overfire air (OFA) in flue gas to react under fuel-lean conditions. The N-agent can also be injected into the reburning zone (AR-Rich), or it can be injected into the burnout zone (Reburn+SNCR).

Recent pilot scale experimental data on different AR systems demonstrate that new technologies can provide over 90% NO_x reduction while firing natural gas and coal. Each AR technology installation on a boiler will require practical expertise and intensive computer modeling to determine the most efficient process parameters such as the amount of the reburning fuel, the amount and location of N-agent injection, spray characteristics, etc. Since the efficiency of AR depends on many factors, the best performance can be achieved if the effects of these factors on the process performance are well determined and understood. The most efficient approach to the AR optimization is to explore the effects of different parameters on NO_x reduction via chemistry-mixing modeling, using the model for guidance to select the most effective test conditions, and then to optimize the technology in pilot- and full-scale combustion facilities.

This paper is focused on AR-Lean and Reburn+SNCR that are the most commercially attractive options among other AR technologies. In AR-Lean, the N-agent is injected along with the OFA and its injection does not require installation of additional ports. There are also several advantages in application of Reburn+SNCR. Optimization of AR technologies was conducted via experiments in 1.0 and 10 MMBtu/hr combustion facilities and via process modeling. The experimental data show that co-injection of N-agent with OFA results in increase of NO_X reduction to over 80%. The model, combining a detailed chemical mechanism with simplified representation of mixing, helped to identify process parameters that affect the NO_X control efficiency.

Application of the model for AR-Lean and Reburn+SNCR optimization is demonstrated. Modeling was used to determine the effects of several process parameters on NO_x control performance. The following parameters were identified as the most important: (1) the amount of the reburning fuel; (2) temperature of flue gas at the point of OFA and N-agent injection; (3) mixing in the OFA/N-agent injection zone; and (4) the amount of N-agent

Modeling predicted that selection of these parameters in the optimum range results in the efficiency of the AR-Lean and Reburn+SNCR processes as high as 90+%. The optimum efficiency depends on the efficiency of SNCR at similar conditions. For a highly effective mixing process with corresponding high efficiency of SNCR, the AR-Lean process is most effective at small heat inputs of the reburning fuel. For conditions when efficiency of SNCR is limited to 50% NO_x reduction, the optimum conditions depend on the amount of the reburning fuel and conditions of N-agent injection.

For conditions at which efficiency of SNCR is limited to 50%, the highest levels of NO_x reduction are achieved at large heat inputs of the reburning fuel. The maximum predicted NO_x reduction for 18% reburning fuel is 80%. Economic evaluation was conducted to quantify the benefits of AR-Lean and Reburn+SNCR in comparison with basic reburning and SCR.